

Application No.: 10/682,154

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A tunnel-injection device, comprising:

a drain region made of a substrate of a first semiconductor;

a reception layer made of ~~[[a]]~~ the first semiconductor disposed on and metallurgically contacted with a top surface of the drain region;

a barrier-forming layer made of a second semiconductor having a ~~bandgap-narrower bandgap energy narrower~~ than the first semiconductor, being in metallurgical contact with the reception layer so as to form a band-edge discontinuity barrier ~~for a tunneling injection of carriers at~~ by a heterojunction interface between the first and second semiconductors;

a gate insulating film disposed on the barrier-forming layer contacting to the heterojunction interface;

a gate electrode disposed on the gate insulating film configured to change a tunneling probability of the carriers, which are configured to be injected into the reception layer by tunneling through the band-edge discontinuity barrier, by controlling a width of the band-edge discontinuity barrier;

~~a drain region made of the first semiconductor, being contacted with the reception layer, configured to receive the carriers injected by tunneling through the barrier;~~

a carrier-supplying region made of the second semiconductor, being contacted with the barrier-forming layer, configured to supply the carriers to the barrier-forming layer; and

a source electrode being contacted with the carrier-supplying region.

Claims 2-3 (Cancelled)

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4. (Withdrawn) The tunnel-injection device of claim 2, wherein conductivity type of the carrier-supplying region is same as the barrier-forming layer.

5. (Withdrawn) The tunnel-injection device of claim 2, wherein impurity-doping level of the carrier-supplying region is higher than the barrier-forming layer.

6. (Withdrawn) The tunnel-injection device of claim 1, wherein the reception layer comprises;

a heavily doped region being metallurgical contacting with the barrier-forming layer; and

a drift layer having impurity-doping level lower than the heavily doped region, being in metallurgical contact with the heavily doped region, configured to transport the carrier to the drain region.

7. (Withdrawn) The tunnel-injection device of claim 1, wherein the carrier-supplying region being stacked on the barrier-forming layer.

8. (Original) The tunnel-injection device of claim 1, wherein the carrier-supplying region and the barrier-forming layer are laminated on the top surface of the reception layer, in a substantially same planar level.

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9. (Original) The tunnel-injection device of claim 1, wherein gate insulating film contacts with the top surface of the reception layer in a window part of the barrier-forming layer being laminated on the top surface of the reception layer.

10. (Withdrawn) The tunnel-injection device of claim 1, wherein gate insulating film contacts with the top surface of the reception layer in a window part of the barrier-forming layer being buried in the reception layer.

11. (Withdrawn) The tunnel-injection device of claim 10, wherein the carrier-supplying region is buried in the barrier-forming layer so that the gate insulating film can cover simultaneously the top surfaces of the reception layer, the barrier-forming layer and the carrier-supplying region.

12. (Withdrawn) The tunnel-injection device of claim 1, wherein gate insulating film is spatially isolated from the top surface of the reception layer by the barrier-forming layer being laminated on the top surface of the reception layer.

13. (Withdrawn) The tunnel-injection device of claim 12, wherein gate insulating film contacts with the top surface of the barrier-forming layer in a window part of the carrier-supplying region being laminated on the top surface of the barrier-forming layer.

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14. (Withdrawn) The tunnel-injection device of claim 12, wherein gate insulating film cover both the top surface of the barrier-forming layer and the top surface of the carrier-supplying region in a substantially same planar level.

15. (Withdrawn) The tunnel-injection device of claim 1, wherein the carrier-supplying region comprises the first semiconductor.

16. (Withdrawn) The tunnel-injection device of claim 15, wherein the carrier-supplying region is buried in the reception layer.

17. (Withdrawn) The tunnel-injection device of claim 16, wherein the barrier-forming layer cover simultaneously the top surfaces of the reception layer and the carrier-supplying region.

18. (Withdrawn) The tunnel-injection device of claim 16, further comprising a body region made of the first semiconductor having an opposite conductivity type of the reception layer, wherein the carrier-supplying region is disposed on the body region.

19. (Withdrawn) The tunnel-injection device of claim 16, wherein the carrier-supplying region serves as a source region of the insulated gate transistor.

20. (Currently Amended) A method for fabricating a tunnel-injection device, comprising:

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preparing a ~~base-body~~ substrate made of a first semiconductor;

homo-epitaxially growing a first layer made of the first semiconductor on a surface of the substrate;

forming a pattern of an insulating film having a first window portion exposing partially a surface of the first layer;

growing a second layer made of a second semiconductor having a ~~bandgap-narrower~~ bandgap energy narrower than the first semiconductor on the insulating film and, through the first window portion, [[a]] on the surface of the base-body first layer so as to form a heterojunction interface between the first and second semiconductors;

doping selectively first impurity atoms in the second layer above the first window portion so as to form a barrier-forming layer made of the second semiconductor, the barrier-forming layer forms a band-edge discontinuity barrier for a tunneling injection of carriers at the heterojunction interface;

doping selectively second impurity atoms with heavier doping level than the barrier-forming layer in the second layer above the insulating film so as to form a carrier-supplying region made of the second semiconductor, configured to supply carriers to the barrier-forming layer;

removing selectively a part of the second layer doped with the first impurity atoms so as to form a second window portion exposing partially the surface of the first layer;

depositing a gate insulating film on the barrier-forming layer and, through the second window portion, on the surface of the first layer so as to contact with the heterojunction interface;

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forming a gate electrode on the gate insulating film, the gate electrode is configured to change a tunneling probability of the carriers, which are configured to be injected into the reception layer by tunneling through the band-edge discontinuity barrier, by controlling a width of the band-edge discontinuity barrier; and

forming a source electrode on the carrier-supplying region.

21. (Original) The tunnel-injection device of claim 1, wherein the first semiconductor is made of SiC.

22. (Original) The tunnel-injection device of claim 1, wherein the second semiconductor is selected from the group consisting of single crystalline silicon, polysilicon and amorphous silicon.

23. (Currently Amended) A tunnel-injection device having a source electrode and a drain electrode, main current flowing between the source and drain electrodes, the tunnel-injection device comprising:

~~means for forming a heterojunction interface so as to generate prohibiting flow of carriers implementing the main current so as to establish cut-off state of the main current, by providing a band-edge discontinuity barrier for a tunneling injection of carriers at the heterojunction interface;~~

means for providing a constant first band gap energy between the band-edge discontinuity barrier and the drain electrode, and receiving the carriers injected by tunneling through the band-edge discontinuity barrier, being contacted with the drain electrode;

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means for providing a constant second band gap energy narrower than the first band gap energy between the source electrode and the band-edge discontinuity barrier, and supplying the carriers so as to accumulate the carriers in front of the band-edge discontinuity barrier formed at the heterojunction interface between the first and second band gap energies, being contacted with the source electrode; and

means for applying an electric field to the band-edge discontinuity barrier, the electric field ~~controls~~ narrows a width of the band-edge discontinuity barrier so ~~as to change that the~~ tunneling probability of the carriers increases so as to establish conducting state of the main current, which are configured to be injected by tunneling through the band edge discontinuity barrier; and

~~means for receiving the carriers injected by tunneling through the band edge discontinuity barrier, being contacted with the drain electrode.~~

24. (New) The tunnel-injection device of claim 1, further comprising a drain electrode being metallurgically contacted with a bottom surface of the drain region.

25. (New) The tunnel-injection device of claim 1, further comprising an insulating film disposed at a limited area of and on a top surface of the reception layer.

26. (New) The tunnel-injection device of claim 25, wherein the carrier-supplying region is disposed only on the insulating film.

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27. (New) The tunnel-injection device of claim 26, wherein the carrier-supplying region is laterally contacted with the barrier-forming layer so as to form junction interface between the carrier-supplying region and the barrier-forming layer on the insulation film.

28. (New) The tunnel-injection device of claim 1, wherein the carrier-supplying region and the barrier-forming layer are made of polysilicon films.

29. (New) The tunnel-injection device of claim 1, wherein the barrier-forming layer has a concaved sidewall on which the gate electrode covers.

30. (New) A tunnel-injection device, comprising:

a reception layer made of a first semiconductor;

an insulating film disposed at a limited area of and on a top surface of the reception layer;

a barrier-forming layer made of a second semiconductor having a bandgap energy narrower than the first semiconductor, being disposed at another limited area of and on the top surface of the reception layer, forming a band-edge discontinuity barrier by a heterojunction interface between the first and second semiconductors;

a gate insulating film disposed at still another limited area of and on the top surface of the reception layer, being contacted with the barrier-forming layer;

a gate electrode disposed on the gate insulating film configured to change a tunneling probability of the carriers, which are configured to be injected into the reception layer by tunneling through the band-edge discontinuity barrier, by controlling a width of the band-edge discontinuity barrier; and

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a carrier-supplying region made of the second semiconductor, disposed only on the insulating film, being laterally contacted with the barrier-forming layer, configured to supply the carriers to the barrier-forming layer.

31. (New) A tunnel-injection device, comprising:

a reception layer made of a first semiconductor;

a barrier-forming layer made of a second semiconductor having a bandgap energy narrower than the first semiconductor, being in metallurgical contact with the reception layer;

a band-edge discontinuity barrier having a barrier height, on which carriers cannot surmount, formed at a heterojunction interface between the first and second semiconductors;

a gate insulating film disposed on the barrier-forming layer contacting to the heterojunction interface;

a gate electrode disposed on the gate insulating film configured to change a tunneling probability of the carriers, which are configured to be injected into the reception layer by tunneling through the discontinuity barrier, by controlling a width of the discontinuity barrier; and

a carrier-supplying region made of the second semiconductor, being contacted with the barrier-forming layer, configured to supply the carriers to the barrier-forming layer.